Joint Appendix JA6

Appendix JA6 – ~~Charge Indicator Display~~HVAC Fault Detection and Diagnostic Technology

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JA6.1 ~~Purpose and Scope~~Charge Indicator Display (CID)

JA6.1.1 Purpose and Scope

Joint Appendix JA6.1 defines required elements for charge indicator display technologies that utilize instrumentation and computer software functionality to monitor and determine the operating performance of vapor compression air conditioning and heat pump systems, to provide visual indication to the system owner/operator if the system's refrigerant charge or metering device performance does not conform to approved target parameters for minimally efficient operation.

JA6.1.2 specifies the required instrumentation, instrumentation accuracy, parameters measured, required calculations, allowable deviations from target values for system operating parameters, and the requirements for system fault indication for a charge indicator display technology that conforms to the methods for verifying refrigerant charge and metering device performance described in Reference Residential Appendix RA3.2.

Charge indicator display technologies other than ~~that~~ what is described in Section JA6.1~~JA6.2~~ are possible, and when vapor compression air conditioner and heat pump system refrigerant charge, metering device and airflow operating performance can be reliably determined by methods and instrumentation other than those specifically defined in section ~~JA6.2,~~JA6.1 such alternative charge indicator display technologies shall be allowed for Charge Indicator Display compliance credit if the manufacturer of the product requests approval from the Executive Director. The Executive Director will grant such approval after reviewing submittals from the applicant. Charge indicator display technologies that are approved by the Executive Director will be published as an addendum to this appendix.

The applicant shall provide information that specifies the required instrumentation, the instrumentation accuracy, the parameters measured, the required calculations, the allowable deviations from target values for system operating parameters, and the requirements for system fault indication.

JA6.1.2 CID Product Approval

Charge indicator display technology manufacturers shall certify to the Energy Commission that the charge indicator display technology meets the requirements of Reference Joint Appendix JA6.1.

JA6.1.3 CID Installation

Charge indicator display devices shall be factory installed by the space-conditioning system manufacturer, or field installed according to the space-conditioning system manufacturer's requirements and the CID manufacturer's specifications.

JA6.1.4 CID Product Documentation

Manufacturers of ~~charge indicator display~~CID technologies shall, upon request, provide comprehensive engineering specification documentation, installation and technical field service documentation, and homeowner user instructions documentation to designers, installers, service personnel and homeowners who utilize the technology.

JA6.1.5 Optional Fault Detection Capabilities

The ~~charge indicator display~~CID may also be used to signal other system operation faults as long as these additional functions do not detract from the proper function of the refrigerant charge, metering device, or airflow operation indications.

~~***JA6.2***~~JA6.1.6 ~~Standard~~ Requirements for a Charge Indicator Display

This section specifies the required instrumentation, the instrumentation accuracy, the parameters measured, the required calculations, the allowable deviations from target values for system operating parameters, and the requirements for system fault indication for a charge indicator display technology.

~~JA6.2.1~~***JA6.1.6.1 Instrumentation Specifications***

Instrumentation for the procedures described in ~~JA6.2~~JA6.1.6 shall conform to the following specifications:

~~***JA6.2.1.1***~~JA6.1.6.1.1 Temperature Sensors

The temperature sensors shall have an accuracy of plus or minus1.8°F ~~1.5°F~~.

~~***JA6.2.1.2***~~JA6.1.6.1.2 Refrigerant Pressure Sensors ~~(if used)~~

Refrigerant pressure sensors, ~~if used,~~ shall have an accuracy of plus or minus 3 percent of full scale.

~~***JA6.2.1.3***~~JA6.1.6.1.3 Parameters Measured

The following parameters shall be measured:

1. Suction line temperature ($T_{suction,}$)
2. Liquid line temperature (T_{liquid})
3. Evaporator saturation temperature or low side refrigerant pressure ($T_{evaporator, sat}$)
4. Condenser saturation temperature or high side refrigerant pressure (~~$T_{evaporator}$~~ $T_{condensor, sat}$)
5. Return air wet bulb temperature or humidity ($T_{return, wb}$)
6. Return air dry bulb temperature ($T_{return, db}$)

7. Condenser air entering dry bulb temperature ($T_{condenser, db}$)
8. Supply air dry bulb temperature ($T_{supply, db}$)

~~JA6.2.2~~JA6.1.6.2 Refrigerant Charge, Metering Device, and Airflow Calculations

Refrigerant charge, metering device and airflow calculations for determining superheat, subcooling, and temperature split values shall conform to the specifications of this section utilizing the measured parameters data from instrumentation as specified in Section ~~JA6.2.1~~JA6.1.6.1.

~~JA6.2.2.1~~JA6.1.6.2.1 Fixed Metering Device Calculations

The fixed metering device calculations are used only for systems equipped with fixed metering devices. These include capillary tubes and piston-type metering devices.

1. Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature. Actual Superheat = $T_{suction,} – T_{evaporator, sat}$.
2. Determine the Target Superheat using Reference Residential Appendix RA3 Table RA3.2-2, the return air wet-bulb temperature ($T_{return, wb}$) and the condenser air entering dry-bulb temperature ($T_{condenser, db}$). If a dash mark is read from Reference Residential Appendix RA3 Table RA3.2-2, the target superheat is less than 5°F.
3. Calculate the difference between Actual Superheat and Target Superheat (Actual Superheat - Target Superheat)

~~JA6.2.2.2~~JA6.1.6.2.2 Variable Metering Device Calculations

The variable metering device calculations are used only for systems equipped with variable metering devices. These include Thermostatic Expansion Valves (TXV) and Electronic Expansion Valves (EXV).

1. Calculate Actual Subcooling as the condenser saturation temperature minus the liquid line temperature. Actual Subcooling = $T_{condenser, sat}$ - T_{liquid}.
2. Determine the Target Subcooling specified by the manufacturer.
3. Calculate the difference between actual subcooling and target subcooling (Actual Subcooling - Target Subcooling.
4. Calculate Actual Superheat as the suction line temperature minus the evaporator saturation temperature. Actual Superheat = $T_{suction} – T_{evaporator, sat}$.
5. If possible, determine the Superheat Range specified by the manufacturer.

~~JA6.2.2.3~~JA6.1.6.2.3 Minimum Airflow Calculations

The minimum airflow calculations are designed to determine whether the rate of airflow across the evaporator coil is above the minimum airflow rate requirement for a valid refrigerant charge test result.

1. Calculate the Actual Temperature Split as the return air dry-bulb temperature minus the supply air dry-bulb temperature. Actual Temperature Split = $T_{return, db}$ - $T_{supply, db}$
2. Determine the Target Temperature Split from ~~Reference Residential Appendix Table RA3.2-3~~Table JA6.1-1 using the return air wet-bulb temperature ($T_{return, wb}$) and return air dry-bulb temperature ($T_{return, db}$).
3. Calculate the difference between target and actual temperature split (Actual Temperature Split - Target Temperature Split).

~~JA6.2.3~~JA6.1.6.3 System Fault Indication

Data from instrumentation specified in Section ~~JA6.2.1~~JA6.1.6.1 and calculations specified in Section ~~JA6.2.2~~JA6.1.6.2 shall be processed and interpreted continuously or at sufficiently frequent time step intervals,

during normal system operation, to insure that system operating conditions that meet the system fault criteria of this section will be detected, and indicated by the charge indicator display. Data from instrumentation specified in ~~JA6.2.1~~Section JA6.1.6.1 and calculations specified in ~~JA6.2.2~~Section JA6.1.6.2 shall be processed and interpreted in a manner that prevents indication of system faults when system fault criteria are triggered by temporary or transitory operating conditions that are not true indicators of problems with refrigerant charge, metering device, or airflow performance.

The charge indicator display shall:

1. be clearly visible to occupants of the home during normal operation.
2. be located on or within one foot of (one of) the thermostat(s) controlling the air conditioner.
3. display an indication of a system fault requiring service or repair when system normal operation fails to meet the required operating performance criteria specified in this section. These system fault indications shall be displayed for a period of at least 7 days after a system fault is detected unless the charge indicator display is reset by the installing or servicing technician.

    a) Refrigerant charge verification criterion for fixed metering device systems.

    If the air conditioner has a fixed metering device, runs for 15 minutes, has a Target Superheat value determined by Reference Residential Appendix RA3 Table RA3.2-2 that is greater than or equal to 5°F, the condenser air entering temperature is greater than or equal to 65°F, and the minimum airflow requirement from item d below is satisfied, then the conditions for a valid refrigerant charge test are satisfied.

    If the conditions for a valid refrigerant charge test are satisfied, and the air conditioner has an Actual Superheat value that deviates more than plus or minus 10°F from the Target Superheat value determined by Reference Residential Appendix RA3 Table RA3.2-2, then the system fails the refrigerant charge test, and a system fault shall be reported.

    b) Refrigerant charge verification criterion for variable metering device systems.

    If the air conditioner has a TXV or EXV, runs for 15 minutes, the condenser air entering temperature is greater than or equal to 65°F, and the minimum airflow requirement from item d below is satisfied, then the conditions for a valid refrigerant charge test are satisfied.

    If the conditions for a valid refrigerant charge test are satisfied, and the air conditioner has an Actual Subcooling value that deviates more than plus or minus 6°F from the Target Subcooling value listed by the manufacturer, then the system fails the refrigerant charge test, and a system fault shall be reported.

    c) Variable metering device function verification criterion.

    If the air conditioner has a TXV or EXV, runs for 15 minutes, the condenser air entering temperature is greater than or equal to 65°F, and the minimum airflow requirement from item d below is satisfied, then the conditions for a valid metering device test are satisfied.

    If the conditions for a valid metering device test are satisfied, and the air conditioner has an Actual Superheat value outside the range specified by the manufacturer (or outside the range 2°F to 28°F if there is no manufacturer's specification), then the system fails the metering device test, and a system fault shall be reported.

    d) Minimum airflow verification criterion.

    If the air conditioner runs for 15 minutes, and the condenser air entering temperature is greater than or equal to 65°F, then the conditions for a valid minimum airflow test are satisfied.

    If the conditions for a valid minimum airflow test are satisfied, and the air conditioner has an Actual Temperature Split value that deviates more than plus 5°F from the Target Temperature Split value determined by Reference Residential Appendix RA3 Table RA3.2-3, then the system fails the minimum airflow test, and a system fault shall be reported.

~~JA6.2.4~~***JA6.1.6.4 ~~Additional System Fault Indication~~Optional Functionality***

The charge indicator display devices may be set to tighter specifications than those specified in Section ~~JA6.2.3~~JA6.1.6.3. The charge indicator display may also be used to signal other system faults as long as these additional diagnostic functions do not detract from the accuracy of the measurement and reporting of system faults as ~~indications~~ specified in ~~JA6.2.3~~Section JA6.1.6.3.

JA6.1.6.4.1 Self Diagnostic Reporting

When equipped with self diagnostic reporting functionality, the CID shall check for communication with every sensor and provide an indication when there are any sensor failures.

JA6.1.6.4.2 Data Access

In order to provide for verification of sensor data and CID system functionality, data access shall be provided. The CID manufacturer shall specify the data access method(s), and the minimum data reporting capability including requirements for any data history reporting.

Table JA6.1-1 Target Temperature Split (Return Dry-Bulb – Supply Dry-Bulb)

Return Air Wet-Bulb (ºF) (T return, wb)

	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
70	20.9	20.7	20.6	20.4	20.1	19.9	19.5	19.1	18.7	18.2	17.7	17.2	16.5	15.9	15.2	14.4	13.7	12.8									
71	21.4	21.3	21.1	20.9	20.7	20.4	20.1	19.7	19.3	18.8	18.3	17.7	17.1	16.4	15.7	15.0	14.2	13.4	12.5								
72	21.9	21.8	21.7	21.5	21.2	20.9	20.6	20.2	19.8	19.3	18.8	18.2	17.6	17.0	16.3	15.5	14.7	13.9	13.0	12.1							
73	22.5	22.4	22.2	22.0	21.8	21.5	21.2	20.8	20.3	19.9	19.4	18.8	18.2	17.5	16.8	16.1	15.3	14.4	13.6	12.6	11.7						
74	23.0	22.9	22.8	22.6	22.3	22.0	21.7	21.3	20.9	20.4	19.9	19.3	18.7	18.1	17.4	16.6	15.8	15.0	14.1	13.2	12.2	11.2					
75	23.6	23.5	23.3	23.1	22.9	22.6	22.2	21.9	21.4	21.0	20.4	19.9	19.3	18.6	17.9	17.2	16.4	15.5	14.7	13.7	12.7	11.7	10.7				
76	24.1	24.0	23.9	23.7	23.4	23.1	22.8	22.4	22.0	21.5	21.0	20.4	19.8	19.2	18.5	17.7	16.9	16.1	15.2	14.3	13.3	12.3	11.2	10.1			
77	-	24.6	24.4	24.2	24.0	23.7	23.3	22.9	22.5	22.0	21.5	21.0	20.4	19.7	19.0	18.3	17.5	16.6	15.7	14.8	13.8	12.8	11.7	10.6	9.5		
78	-	-	-	24.7	24.5	24.2	23.9	23.5	23.1	22.6	22.1	21.5	20.9	20.2	19.5	18.8	18.0	17.2	16.3	15.4	14.4	13.4	12.3	11.2	10.0	8.8	
79	-	-	-	-	-	24.8	24.4	24.0	23.6	23.1	22.6	22.1	21.4	20.8	20.1	19.3	18.5	17.7	16.8	15.9	14.9	13.9	12.8	11.7	10.6	9.4	8.1
80	-	-	-	-	-	-	25.0	24.6	24.2	23.7	23.2	22.6	22.0	21.3	20.6	19.9	19.1	18.3	17.4	16.4	15.5	14.4	13.4	12.3	11.1	9.9	8.7
81	-	-	-	-	-	-	-	25.1	24.7	24.2	23.7	23.1	22.5	21.9	21.2	20.4	19.6	18.8	17.9	17.0	16.0	15.0	13.9	12.8	11.7	10.4	9.2
82	-	-	-	-	-	-	-	-	25.2	24.8	24.2	23.7	23.1	22.4	21.7	21.0	20.2	19.3	18.5	17.5	16.6	15.5	14.5	13.4	12.2	11.0	9.7
83	-	-	-	-	-	-	-	-	-	25.3	24.8	24.2	23.6	23.0	22.3	21.5	20.7	19.9	19.0	18.1	17.1	16.1	15.0	13.9	12.7	11.5	10
84	-	-	-	-	-	-	-	-	-	25.9	25.3	24.8	24.2	23.5	22.8	22.1	21.3	20.4	19.5	18.6	17.6	16.6	15.6	14.4	13.3	12.1	10

JA6.2 Saturation Pressure Measurement Sensors

JA6.2.1 Purpose and Scope

Appendix JA6.2 specifies the required instrumentation, and the instrumentation accuracy, for a saturation pressure measurement (SPMS) device intended to provide a means for a HERS Rater to observe space conditioning system refrigerant pressure measurement data without attaching refrigerant gages to the refrigerant system service access ports.

The SPMS device manufacturer shall provide certification to the commission that the SPMS device will and approved for use by the Commision

JA6.2.2 SPMS Device Approval

SPMS devices, if approved by the Executive Director, shall be allowed for use for determining compliance with the refrigerant charge verification requirements in the Standards. The Executive Director will grant such approval after reviewing submittals from the applicant. SPMS devices that are approved by the Executive Director will be listed as approved SPMS devices in directories published by Energy Commission.

Manufacturers of approved SPMS devices shall, upon request, provide comprehensive engineering specification documentation, installation and technical field service documentation, and user instructions documentation to installers and service personnel that utilize the procedure.

JA6.2.3 Standard for Saturation Pressure Measurement Sensors

SPMS devices shall measure and report the refrigerant system pressure for both the high pressure side and the low pressure side of the refrigerant system within the tolerances given in Section JA6.1.2.2.1.

JA6.2.3.1 Instrumentation Specifications

The pressure measurement instrumentation shall have an accuracy of ±3 percent of discharge pressure and ±1.0 psig suction pressure.

JA6.2.3.2 Installation

SPMS devices shall be installed by the space-conditioning equipment manufacturer, or installed in the field according to any applicable space-conditioning equipment manufacturer requirements, within 12 inches of the refrigerant system service port.